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The Motor Control Theory and How It Is Being Incorporated into Present Physical Therapy Curricula

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THE MOTOR CONTROL THEORY AND HOW IT IS BEING INCORPORATED
INTO PRESENT PHYSICAL THERAPY CURRICULA

by

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Bachelor of Arts in Physical Therapy
College of St. Scholastica, 1988

An Independent Study

Submitted to the Graduate Faculty of the

Department of Physical Therapy

School of Medicine

University of North Dakota

in partial fulfillment of the requirements

for the degree of

Master of Physical Therapy



Grand Forks, North Dakota

May
1993

This Independent Study, submitted by Laurie Toulouse Jung in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

A handwritten signature in black ink, appearing to read "H. Jung", written over a horizontal line.

(Chairperson, Physical Therapy)

PERMISSION

Title The Motor Control Theory and How it is Being Incorporated
 Into Present Physical Therapy Curricula

Department Physical Therapy

Degree Master of Physical Therapy

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ABSTRACT

The Motor Control Model or Theory is a conglomeration of recent studies by professionals and scientists from a wide variety of fields. This theory on motor control consists of concepts and ideas that can be used by therapists to treat neurologically impaired patients. Its theories are different from the traditional Facilitation Model theories which are based on Rood, Brunnstrom, PNF, and NDT. Because the Motor Control Theory is a new and valuable tool for physical therapists to use in the clinic, it is important that it be introduced to present and future physical therapists.

The purpose of this study was to determine if the Motor Control Theory is being incorporated into the present physical therapy programs across the country. To determine this, a questionnaire/survey was sent to the physical therapy program directors of the 122 United States physical therapy programs identified in 1992 by the American Physical Therapy Association. The survey consisted of 12 questions including an open-ended question asking for any additional comments on the Motor Control Theory.

The program directors or appropriate faculty members of 88 of the 122 surveyed PT programs returned completed questionnaires. The results showed that the number of hours devoted to the Motor Control Theory varied greatly, from 1 to 76. When this topic was added to the curriculum also varied in a

range from 1992 to 1962. The most significant finding of the study was that it is apparent that there is not a consensus on the exact definition of the Motor Control Theory, nor how it relates to the older models of motor control.

CHAPTER I

INTRODUCTION

Physical therapists have traditionally studied recovery from cerebral disorders using a facilitation-based model which focused on the works of Rood, Brunnstrom, Bobath, and Kabat.¹ Collectively, they approach treatment and recovery from cerebral disorders on:²

- 1) use of sensory input to facilitate or inhibit motor function;
- 2) use of the normal human motor development in treatment;
- 3) understanding of the role of reflexes in facilitation or inhibition of voluntary motor activity;
- 4) use of multiple motor repetitions in the program;
- 5) integration of the body and its parts as a whole; and
- 6) emphasis on the importance of therapist-patient interactions.

These neurophysiological, traditional approaches were developed in the 1950s. Prior to this time, the majority of physical therapy was concerned with the treatment of poliomyelitis which emphasized muscle reeducation.

Poliomyelitis actually produced a lower motor neuron lesion associated with the peripheral nerve or anterior horn cell.¹ After the Salk vaccine helped to reduce the incidence of poliomyelitis, the emphasis in physical therapy shifted to the

central nervous system and upper motor neuron lesions such as stroke and head injury. It is this shift that produced the Facilitation Model.¹

Gordon¹ emphasized five primary assumptions in the Facilitation Model:

- 1) The brain controls movements, not muscles.
- 2) We can alter, or facilitate, a patient's movement patterns by applying specific patterns of sensory stimulation, especially through proprioceptive afferent pathways.
- 3) The CNS is hierarchically organized, with higher centers normally in command of lower centers, which in turn control primitive and more automatic behaviors.
- 4) Recovery from brain damage follows a predictable sequence that mimics the normal development of movement during infancy.
- 5) All motor phenomena associated with brain damage have a neurophysiological basis.

Gordon¹ points out that one of the main problems with the Facilitation Model is the problem of functional carry-over. The Facilitation Model believes that therapists can reinstate normal movement patterns in daily activities. In reality, most patients use movements different when performing functional tasks than they are taught during treatment sessions. Two of the main reasons the Facilitation Model is currently being challenged is because the current approaches are not adequate to solve clinical problems as they are perceived

by therapists, and the theoretical assumptions underlying current approaches do not fit with current knowledge.

In recent years, new research has attempted to find answers to some of the challenges of the Facilitation Model. As a result of this research, a new model has arisen called the Motor Control Model or Theory.¹

As noted above, the Facilitation Model is reflex based. The treatment strategies attempt to elicit "normal" reflexes while suppressing or inhibiting abnormal, pathological reflexes. The Motor Control Model challenges this belief by research which has shown that relatively normal movement patterns are possible when all the sensation from the moving limbs has been eliminated.³ This takes into account the ability of a person to adapt more quickly than a reflex would allow. Therefore, skilled movement is dependent upon preplanned patterns of neural output to muscles. Such preplanned patterns are referred to as motor programs, or engrams.

The Facilitation Model is based on closed-loop tasks where movements are made by comparing ongoing feedback from limbs or other senses; therefore, it is feedback referenced to a template. The Motor Control Model is based on open-loop tasks where movements are feedforward and referenced to allow anticipation of movement responses.

In regard to the role of sensation, the Facilitation Model considers sensation a regulatory process, where sensation guides movements while they are being performed.¹ The Motor Control Model considers sensation both as

regulatory and adaptive. The adaptive role is the anticipatory ability to allow sensation to influence succeeding movements.

Since the Motor Control Model is challenging the traditional Facilitation Model, it is important that it be introduced to the present and future physical therapists. It would be of benefit to know if the Motor Control Model is being included in the curricula of the present physical therapy programs across the country. The purpose of this study is to determine if the Motor Control Model or Theory has been integrated into the curricula of the physical therapy programs. An appropriate way to determine this was through a survey of the programs themselves.

CHAPTER II

LITERATURE REVIEW

The Facilitation Model and the Motor Control Model can be compared in four areas, including normal movement control, skill acquisition, dyscontrol, and recovery of function.

The Motor Control Model originated from a conglomeration of recent studies by professionals and scientists from a wide variety of fields including physical therapy, human kinetics, human movement studies, kinesiology, neurology, neurophysiology, physical education, psychology, and rehabilitation medicine.⁴ Many of the ideas were presented to physical therapists at the II STEP (Special Therapeutic Exercise Project) conference⁵ in July of 1990. This conference resulted in a publication of the ideas presented. Some of the studies and concepts were also published in a special series section in Physical Therapy from December, 1990 through March, 1991.

The Motor Control Model is a theory based on a systems model of motor control which is also referred to as a task-oriented approach to treatment of neurologically involved patients. One of the first major assumptions of the Motor Control Model or systems model is that the nervous system is organized to control the end points of motor behavior, which is the accomplishment of task goals.⁶ Control is not over muscles or sensory receptors, but over abstract

aspects of motor behavior, so the control of movement is organized along goal-directed, functional behaviors, rather than by specific muscle or movement patterns. This then makes the environment, and how the environment affects movement, an important aspect of the treatment program. This approach also assumes that the therapeutic influence on motor control should be aimed at both the peripheral and central nervous systems.⁶ The goal of the therapist is to teach the patient to gain control over abstract aspects of motor behavior rather than to elicit control over muscle activation patterns or individual muscle groups. Since the same task may be accomplished with a wide variety of movement patterns, the therapist does not limit training to any one normal movement pattern, but instead allows the patient to learn alternative movement strategies for varying situations. This assumption differs from the Facilitation Model, since that model advocates facilitation of normal movement patterns by utilization of proprioceptive input. This is a much more passive approach on the part of the patient than the systems model, as the systems model encourages the patient to problem solve to achieve the functional goal, whether that be through normal or abnormal movement patterns.⁶

The systems model looks at the organizing principles of a normal movement strategy, and what constraints are preventing normal movement strategies in the patient. These movement strategies are the large scale plans for how to artfully accomplish a goal.⁶ The inability of a patient to perform a normal movement strategy may be due to a wide variety of neural and

biomechanical restraints. Therefore, with this approach, the therapist has to analyze whether the abnormal movement strategy is due to a primary lesion in the central nervous system or the natural compensation processes that attempt to maintain behavioral functions in spite of the lesion. With the systems model, the patient is learning to problem-solve by utilization of these movement strategies. The therapist may help direct the patient by assisting the patient in developing learning strategies to achieve the desired goal or behavior. The learning environment therefore becomes critical.

Another assumption of the Motor Control Model is that the nervous system adapts to, and predicts, constraints placed on movement by the physical laws associated with the musculoskeletal system and its environment.⁶ This means that the nervous system is continually comparing anticipated and actual interactions with the environment, and constantly modifying its model to determine the most effective and kinematically efficient means to accomplish the goals of the task. The goals are behavioral; therefore, in order to attain them, the tasks have to be functional, as opposed to a goal of eliciting a reflex or motor pattern in isolation, as is the focus of the Facilitation Model. This leads to a clinical advantage for the Motor Control Model, as it can account for the flexibility and adaptability of motor behavior in a wide variety of environmental conditions.⁶

Another major assumption of the Motor Control Model involves normal movement control. Traditionally, in the Facilitation Model, many treatment

strategies attempt to elicit normal reflexes while suppressing or inhibiting abnormal or pathological reflexes. Reflexes are also regarded as a useful way to activate the damaged central nervous system. Recently, the importance of reflexes in normal, ongoing movement control has been questioned.¹ Several studies have shown that relatively normal patterns of movement are possible even when all sensation from the moving limbs has been eliminated.³ The current view of the Motor Control Model is that most skilled movements are dependent on preplanned patterns of neural output to the muscles, referred to as motor programs.¹ A motor program is defined as an abstract representation of a movement sequence that is stored in memory and contains certain variant and invariant features.³ Most simple movements occur too fast for reflexes to have time to influence them; therefore, performance of motor tasks in complex environments must be governed by a predictive mode of control rather than merely a reactive one, thus the motor program or engram.¹ Even the basic function of postural control does not, and cannot, rely on reflexes, since it has been shown that postural contractions actually occur before forward sway begins.⁷ This implies that a treatment strategy that emphasizes reflexes is not preparing patients to function in the real world. Effective maintenance of body equilibrium is achieved by predicting the consequences of our movements, and precompensating for them, rather than by awaiting the consequences and reacting to them.

Predictability of the nervous system implied by the Motor Control Model implies a new term referred to as the "central set." The central set is the ability of the nervous system to prepare the motor system for upcoming sensory information and to prepare the sensory system for upcoming movement.⁶ For example, it is used to help predict the weight of an object and the dynamics of our upper extremities when performing complex bilateral tasks. The central set is based on prior experience, with analogy to a template, and is used to determine variables of movement when first encountering a new situation during the time delay it takes for sensory feedback to be used to update the system.⁶

The Facilitation Model has also emphasized the particular importance of proprioceptive input in the ongoing control of movement with the utilization of manual techniques to stimulate certain movement.⁶ Thus patients are learning to react to proprioceptive input, rather than learning to use proprioceptive input to improve their movement patterns. This leads to an emphasis on eliciting reactions rather than on helping the patient to learn to function in a predictive or feedforward mode. The Motor Control Model emphasizes feedforward as an automatic response, so the patient learns to anticipate an action rather than wait and react to an action. Mulder⁸ described feedforward as the sending of some signal ahead of the response in order to prepare the system for input. He goes on to explain that the basic ideal is that efferent information heading for the effector mechanism is also sent to brain areas that are primarily sensory in nature. This information alerts these areas to anticipate the arrival of the

response-produced feedback. A reference of correctness, or a template, is then established against which the feedback of the actual movement will be compared.

Many of the studies supporting the Motor Control Model center around learning, and how the patient learns to problem-solve. The results of these studies have also suggested ways the therapist can best assist the patient in this problem-solving process. A therapist using the Motor Control Model in the clinic is trying to help the nervous system learn to solve the problems associated with motor deficits in a variety of ways, rather than trying to stimulate a particular muscle activation pattern. Because the same task may be accomplished effectively with a wide variety of movement patterns, therapists should not limit training to one normal movement pattern, but allow patients to learn alternate movement strategies to coordinate motor behaviors as efficiently as possible.⁶ The therapist does not try to facilitate normal movement patterns for every possible situation, but tries to help teach the nervous system how to solve those types of motor problems by practicing tasks in a wide variety of environments. Therefore, how the patient practices becomes important.

Schmidt⁹ reviewed several learning theories and studies that focused on two broad categories--the effects of performance of an activity that were momentary or temporary, and those effects that were lasting or permanent in relation to skill acquisition. It was found that performance during practice was

not a particularly useful criterion for learning, but rather the goal of practice should be the capability to retain what has been learned. Other studies reviewed by Schmidt⁹ indicated that therapeutic variables can generate large improvements in performance during practice, but may not be that effective for learning. This indicates that the focus of therapy sessions should not be on the particular practice session at hand, but rather on the ability of the patient to carry over what was learned in the practice session to real life situations. To facilitate this, random practice was found to be more beneficial than blocked practice, as random practice promotes retention even though it may degrade performance during practice.⁹ In addition, these same studies found that during a practice session using summary feedback, which is feedback withheld for a set of trials, greater retention was promoted than with immediate feedback. The reduction of feedback frequency in practice also provided gains in the capability to perform.⁹ Clinically, this indicates that the therapist should provide feedback less frequently, or in a summary or average form, by altering the way the therapist reports errors in performance to the patient. The therapist should also organize practice in a way that maximizes retention by making things somewhat difficult for the patient, and not implying that a good job was done when this may not be the case.

Lee, Swanson, and Hall¹⁰ analyzed repetition and its influence on improvement of acquired motor skills. They argued that repetition involved not only the physical act of repetition, but also the cognitive processes that

determine and affect repetition of a movement. These cognitive processes are the conscious, goal-directed thoughts and behaviors that occur before, during, and after an action. Since practice is the key ingredient in learning a motor skill, and movement repetition is the key ingredient in practice, their study reviewed some features of learning that are affected by specific structured practice situations.

The two ways in which we learn are by blocked-order or random-order schedules.¹⁰ We tend to learn better if we are able to repeat the process of learning, rather than repeating the means of the solution. In order to gain skill, we need to learn to construct an appropriate action plan. Therefore, when studies compare blocked-order versus random-order knowledge of results, the random-order knowledge of results forced the learner to more fully plan the entire action in advance.¹⁰ With blocked-order knowledge of results, the learner tended to prepare for only part of the movement in each trial. Therapists need to consider what is actually being repeated in the repetition of motor tasks during the rehabilitation process. These findings suggest that perhaps the improvement achieved within the physical therapy session as a result of repetition of movement and knowledge of results may produce only temporary changes. Therefore, perhaps the structure of practice and the scheduling of knowledge of results need to be altered in order to enhance learning rather than performance.¹⁰

CHAPTER III

METHODOLOGY

A questionnaire/survey accompanied by a self-addressed envelope was mailed to the physical therapy program directors of the 122 United States physical therapy programs identified in 1992 by the American Physical Therapy Association. All of the schools were accredited bachelor's or entry level master's degree programs.

A letter also accompanied the survey, briefly explaining the purpose of the study, and identifying two literature sources on the Motor Control Theory. These two sources were the proceedings from the II STEP conference⁵ and the Movement Science series in the Physical Therapy Journals.⁴

The survey consisted of 12 questions addressing such areas as the level of the physical therapy program; if the Motor Control Theory was included in the curriculum; when the unit was added; the number of lecture hours allotted to this topic; who teaches the unit; the length of teaching experience of the instructors; the type of materials required for the unit; how the Motor Control Theory was correlated with the units on Brunnstrom, NDT, PNF, and Rood; and whether the Motor Control Theory unit was optional. The last question asked for any additional comments on the Motor Control Theory

Data Analysis

The data from the survey were reviewed in both a numerical and descriptive manner. Since some of the responses were more elaborate than others, the results of those questions will be discussed in greater detail.

CHAPTER IV

RESULTS

A. Entry Level MPT versus Bachelor's Degree Programs.

The program directors or appropriate faculty members of 88 of the 122 surveyed PT programs returned completed questionnaires. Of these 88 programs, 42 offered the bachelor's degree, 36 offered the MPT degree, and 6 offered the MSPT degree. In addition, 4 other programs indicated they offered the following: both the MPT and bachelor's degrees; both the bachelor's and MHS degrees; both the MSPT and bachelor's degrees; and one indicated it was in transition from the bachelor's to the MPT degree.

B. When the Motor Control Theory Unit was Added.

All of the 88 programs indicated that the Motor Control Theory was included in their present PT curricula; however, the year that the unit was added varied greatly. As indicated in Table 1, the majority of programs added the unit in 1989, 1990, and 1991, as these three years accounted for 59 of the 88 programs. The year 1990 had the greatest number of responses for when the unit was added (27 of the 88 programs). The II STEP conference was held in 1990.

C. Number of Lecture Hours.

The responses to the question regarding the number of lecture hours allotted to the Motor Control Theory varied greatly. As indicated in Table 2, the greatest number of programs indicated they allotted 20 hours to the topic. This was 8 out of the 88 programs. The range of hours was from 1 hour to 76 hours. Seventeen of the 88 programs indicated the topic of Motor Control was integrated throughout other courses and labs.

D. Who Teaches the Unit.

This question asked if a PT faculty member, nonfaculty member, or other taught the Motor Control Theory unit. Seventy-eight of the 88 programs indicated a PT faculty member taught the unit, 6 had a PT faculty and nonfaculty member teach the unit, and one indicated a PT nonfaculty member taught the unit. In addition, one school utilized both a PT faculty member and nonfaculty member as well as an occupational therapist; another utilized a PT faculty member and an occupational therapist. Finally, one school did not indicate any of the above, but commented "Who has a PhD in Motor Control?".

E. Length of Teaching Experience of the Instructors.

When reviewing the question asking the length of teaching experience of the instructors of the Motor Control Theory, it was noted that 11 of the 88 schools answering the survey stated that more than one instructor taught the unit. These schools listed the teaching experience of each of the instructors. As noted in Table 3, the majority of teaching experience was 6-10 years (25 of

the 88 returned surveys), followed by 3-5 years (23 of the 88), and 1-2 years (12 of the 88). Eight of the schools listed their faculty's teaching experience in a range greater than the ranges listed in Table 3 and those were as follows: 3-8 years; 2-5 years; 2-8 years; 10-15 years; 5-25 years; 10-20 years; and two indicated 2-20 years. Five of the returned surveys did not answer the question numerically, so they were not included in the table.

F. Is the Motor Control Unit Optional.

None of the schools answering the survey indicated that the Motor Control unit was optional.

G. Materials/Resources Required for the Unit.

The 88 schools answering the survey listed a total of 19 different resources for teaching this unit on Motor Control. The majority of the schools listed more than one resource. The top three resources were as follows: Contemporary Management of Motor Control Problems: Proceedings of the II STEP Conference⁵ (26 of the 88 responding schools); Motor Control and Physical Therapy: Theoretical Framework and Practical Applications¹¹ by Montgomery and Connolly (17 of the 88 responding schools), and Movement Science: Foundations for Physical Therapy in Rehabilitation¹² by Carr, Shepherd, Gordon, Gentile, and Held (14 of the 88 responding schools). Specifically, chapters 4, 5, 6, 12, and 18 of the II STEP proceedings were mentioned in the surveys. Table 4 lists all of the resources mentioned in the surveys.

H. How the Motor Control Theory Correlates with the Units on Brunnstrom, NDT, PNF, and Rood.

This was a difficult question to interpret as there was a wide variety of answers and some respondents indicated that the question was too vague to answer. There were, however, different directions that the instructors took in teaching the Motor Control Theory. Several schools stated that the Motor Control Theory was incorporated into the units on Brunnstrom, NDT, PNF, and Rood. In addition, several schools stated that they compared/contrasted the latter theories with the Motor Control Theory. The following responses, which are noted below, are representative of all of the varying answers.

- 1) "It is introduced following Brunnstrom, NDT, PNF, and Rood (in the junior year). The Systems Approach is then discussed in the Fall and Hierarchical Approaches are then discussed with the Motor Control Theory in their application to clinical cases."
- 2) "Provide a historical perspective. Examination of techniques--how can approaches be incorporated with the Motor Control approach."
- 3) "Presented as an alternative theory for treatment."
- 4) "As another theory, not as a "conflicting" unit."
- 5) "Newer philosophy without well-defined clinical application."
- 6) "Via problem-solving labs."
- 7) "It is presented before the traditional techniques."

- 8) "As an overriding philosophy where the other units fit into. I use Brunnstrom, Rood, Bobath, and PNF as modalities in a motor control model stressing decrease feedback, more motor planning, and the environment."
- 9) "We don't teach the "Motor Control Theory"; we look at the pluses and minuses of the "named approaches" in how well they address Motor Control and Motor Learning issues."

I. Additional Comments on this Topic.

Twenty of the 88 respondents chose to respond to this final open-ended statement asking for any additional comments on the Motor Control Theory.

Stated below are several of these comments.

- 1) "You should review your assumptions. The II STEP conference did not initiate the teaching of motor control in many curricula. It's been there for a long time."
- 2) "It was implemented before II STEP and further revised since then."
- 3) "I think the Motor Control Theory is complimentary to the other theories and is a natural progression of where our profession is--I don't think it is a challenge to the older models."
- 4) "There is no such thing as the Motor Control Theory."
- 5) "I don't know exactly what you mean by "The Motor Control Theory."
Do you mean theories of motor control in general or motor programming theory, motor learning theory, etc.?"

- 6) "Have MCT improved Care? Practice? Results?"
- 7) "There is no one "Motor Control Theory"."
- 8) "I believe it is important to maintain the integrity of our foundation in neurorehabilitation and these former tools are of great benefit.
Embracing the concepts of motor control as a theme in all these principles is important as well."
- 9) "I think students are looking for clinical guidance on how to apply these theories in various diagnosis in practical terms."
- 10) "As one of the two CoChairs of II STEP I want to clarify a common misconception. Motor Control Theory is not either challenging or replacing traditional facilitation models, rather it presents a different orientation to and basis upon which to look at these models. I think there was a bit of a scare in terms of "throwing the baby out with the bath water," but that was neither the intention nor the case."
- 11) "I fear you are making an erroneous assumption that there is one singular Motor Control Theory. If you read Fay Horak's chapter in the proceedings from II STEP you will find that Dr. Horak addresses "Motor Control Models." Just as there are different proposed models of motor control, there are also motor control principles and theories. No one can teach "the Motor Control Theory" because it would be like asking someone to teach "the strength theory" or the "coordination theory." Motor Control exists--in patients with dysfunction their motor control

may not be as flexible as that of an intact individual, but they show the best they have. We lecture and do labs to investigate the common organizing features of motor control. We then look critically at the "names" approaches--Brunnstrom, Bobath, PNF, Rood, Carr, and Shepherd and ask how well their clinical ideas complement that which we know of motor control. We then spend lecture and lab time investigating the process of motor learning and critically ask the same questions of the "names" approaches in regard to what type of motor learning is occurring within and between treatment sessions. Again, motor control and motor learning are processes, numerous and complex. One may emphasize the importance of these processes in rehabilitation, but certainly one cannot create a theory or rehabilitation approach which encompasses all that is entailed in those processes."

CHAPTER V

DISCUSSION/CONCLUSION

After reviewing all of the returned surveys, one of the main themes that was apparent throughout was that there is not a consensus on exactly what comprises the Motor Control Theory. Some of the respondents indicated that they were not exactly sure what this author meant by the Motor Control Theory, and that there was no one "motor control theory." It was evident that there are many new ideas about the topic of motor control and that there is research to back these ideas. However, it is also clear that the Motor Control Theory is not trying to replace or challenge the Facilitation Model, as was initially stated in the introduction. The physical therapy programs generally stressed that they were teaching the Motor Control Theory as another tool for the physical therapist to use.

There was a wide variance in the number of lecture hours devoted to the topic of motor control and when the motor control unit was added. This indicates that the physical therapy programs are not all in concert as to the importance of the new research regarding motor control and what should be taught to students regarding this newer model of motor control.

The Motor Control Theory is a complicated concept. One of the surveys suggested reviewing Fay Horak's article⁶ in the II STEP proceedings. That

article does a very good job showing how this new research on motor control fits into the older models of motor control. Horak states that there are thousands of documented models of motor control, and each is more or less useful for different purposes.⁶ Specifically, she reviews the reflex model, the hierarchical model, and the systems model of motor control. One of the primary differences in these models is in their goals. The goal of the reflex model is to control muscle activation; the goal of the hierarchical model is to control movement patterns; and the goal of the systems model is to control motor performance in behavioral tasks.⁶ The emphasis on behavioral tasks, rather than on controlling muscle activation or motor patterns in isolation, is a new theme that is arising when looking at motor control. Rather than looking so specifically at how the limb is functioning, as the facilitation model does, the emphasis should be on what the patient needs to accomplish overall.

Horak⁶ also explained the motor control concepts by looking at the neurologic rehabilitation models. She divided these treatment models into three categories--muscle reeducation; neurotherapeutic facilitation, based on the reflex and hierarchical models of motor control; and the task-oriented model based primarily on the systems model of motor control.⁶ By categorizing motor control and neurologic rehabilitation models, it becomes much clearer how the different models of motor control fit together.

This study has reviewed some of the current literature on motor control, movement patterns, the affects of sensory input on motor output (as in the

feedforward ideas), and the importance of behavioral task goals in treatment. The physical therapy programs are all on different levels in teaching these ideas and how these ideas relate to some of the established models of motor control. This indicates that there may be a need for further continuing education on this topic for both the instructors and the physical therapy graduates who may not have been educated in these newer ideas. Physical therapists need to have a common understanding of the systems model of motor control and the task-oriented model of neurologic rehabilitation.

APPENDIX A

Table 1.--The Year the Motor Control Theory Unit Was Added
to the 88 Physical Therapy Curricula

| Year | Number of Programs |
|-------------|---------------------------|
| 1992 | 3 |
| 1991 | 19 |
| 1990 | 27 |
| 1989 | 13 |
| 1988 | 8 |
| 1987 | 7 |
| 1986 | 2 |
| 1985 | 1 |
| 1982 | 2 |
| 1972 | 1 |
| 1962 | 1 |
| Total | <u>84</u> |

Other Comments

| | |
|-----------------------|----------|
| Was there already | 1 |
| Has always been there | 1 |
| Total | <u>2</u> |

- * Two other survey responses confused this question and indicated at what point in their program they teach the unit.
- * For clarification, if a school responded that the unit was added two years or three years ago, this was counted as 1990 or 1989, respectively.

Table 2.--The Number of Lecture Hours the Physical Therapy Program Allotted to the Motor Control Theory

| Number of Hours | Number of Programs |
|-----------------|--------------------|
| 1 | 2 |
| 2 | 7 |
| 3 | 6 |
| 4 | 6 |
| 5 | 6 |
| 6 | 7 |
| 8 | 7 |
| 10 | 5 |
| 12 | 3 |
| 13 | 1 |
| 14 | 2 |
| 15 | 5 |
| 16 | 3 |
| 18 | 2 |
| 20 | 8 |
| 24 | 2 |
| 25 | 1 |
| 27 | 1 |
| 30 | 3 |
| 32 | 1 |
| 45 | 1 |
| 50 | 1 |
| 60 | 1 |
| 76 | 1 |
| Total | <hr/> 82 |

Other

| | |
|-------------------------------------|---------|
| Incorporated in a four unit course. | 1 |
| Integrated in a five credit course. | 1 |
| Three credit hours. | 1 |
| No response. | 1 |
| Total | <hr/> 6 |

Table 3.--Length of Teaching Experience of the Instructors Teaching
the Unit on The Motor Control Theory

Years of Teaching Experience Number of Faculty

| | |
|------------|----|
| 1-2 | 12 |
| 3-5 | 23 |
| 6-10 | 25 |
| 11-15 | 10 |
| 16-20 | 11 |
| 21 or more | 7 |

Table 4.--Resources the Respondents Listed for Teaching the
Unit on the Motor Control Theory

Author(s) and Title

- 1) Barnes, Crutchfield, Heriza, and Herdman. Reflex and Vestibular Aspects of Motor Control, Motor Development and Motor Learning.
- 2) Duncan. Steps to Follow.
- 3) Duncan. Stroke Rehabilitation.
- 4) Carr, Shepherd, Gordon, Gentile, and Held. Movement Science: Foundations for Physical Therapy in Rehabilitation.
- 5) Foundation for Physical Therapy. Contemporary Management of Motor Control Problems: Proceedings of the II STEP Conference.
- 6) Montgomery and Connolly. Motor Control and Physical Therapy: Theoretical Framework and Practical Applications.
- 7) Physical Therapy. Movement science series. December 1990 through March 1991.
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- 9) Sullivan and Schmitz. Physical Rehabilitation: Assessment and Treatment.
- 10) Umphred. Neurological Rehabilitation.

APPENDIX B

MOTOR CONTROL THEORY SURVEY

Name of Institution _____

Date _____

Please answer the following questions and return to me in the self-addressed envelope. I would welcome any additional comments at the end of the survey.

- 1) What is the level of your physical therapy program? _____ M.P.T.
_____ Bachelor's
- 2) Is the Motor Control Theory included in your present physical therapy curricula?
- 3) When was the unit added to your curricula?
- 4) How many lecture hours are allotted to this topic?
- 5) At what level are the students who take this unit?
- 6) Who teaches the unit? (Circle all that apply.)
 - a) P.T. faculty member
 - b) P.T. nonfaculty member
 - c) other
- 7) What is the length of the teaching experience of the unit instructors?
- 8) What type of materials/resources do you require for the unit?
 - a) Book _____ (title)
 - b) Other (articles, etc.):
- 9) How is instruction in the Motor Control Theory correlated with the units on Brunnstrom, NDT, PNF, and Rood?
- 10) Is the Motor Control Theory unit optional?
- 11) If you do not already have a unit on the Motor Control Theory, are you planning to add one in the near future? If so, when?
- 12) Additional Comments on this topics:

Please indicate below if you would like a copy of the results of this survey.
Thanks.

Name/Address: _____

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